

NAME (from your UF ID): _____ UF ID#: _____
(Please **PRINT**)

----- CEN 4072/6070 Software Testing & Verification -----

Quiz 4 -- Spring 2017

You have 30 minutes to work on this quiz. It is a "closed-book/closed-notes" test. Pay attention to point values, since you may not have time to work all 5 problems.

PRINT your name and UF ID# above NOW and sign the pledge at the bottom of this page, if appropriate, when you are finished.

PLEASE PRINT – **do NOT write *cursively*** – ANSWERS IN THE SPACE PROVIDED ONLY – **NOT IN THE MARGINS** – PREFERABLY USING A BALLPOINT PEN TO INCREASE LEGIBILITY. Good luck!

On my honor, I have neither given nor received unauthorized aid on this exam and I pledge not to divulge information regarding its contents to those who have not yet taken it.

SIGNATURE

1. (14 pts.) From Problem Set 6, it was determined that H_1 , H_2 , H_3 , and H_k in the *open-form* expression of the *weakest pre-condition* (wp) of program R:

```
Repeat
  x := x+1;
  y := y-1
Until y=0
```

with respect to post-condition ($x=17$) are:

$$H_1: y=1 \wedge x=16$$

$$H_3: y=3 \wedge x=14$$

$$H_2: y=2 \wedge x=15$$

$$H_k: y=k \wedge x=(17-k)$$

where x and y are integers.

Answer questions (a) through (g) below by identifying the **SINGLE MOST APPROPRIATE EXPRESSION OR VALUE AMONG THE FOLLOWING**. Expressions/values may apply to none, one, or more than one question. (Note: assume that y' represents the *initial* value of variable y .)

A. $H_1 \vee H_2 \vee H_3 \vee \dots \vee H_k \vee \dots$

B. $y > 0 \wedge x = 17 - k$

C. $x = 7 - y$

D. $(x = 17 - y) \vee (y < 0)$

E. true

F. $y \geq 0 \wedge x = 17 - y$

G. $(y = 0 \wedge x = 5 + y') \vee \text{"undefined"}$

H. $[y' > 0 \Rightarrow (y = 0 \wedge x = 5 + y')] \wedge (y' \leq 0 \Rightarrow \text{"undefined"})$

I. $k > 0 \wedge x = 17 - k$

K. $y > 0 \wedge x = 17 - y$

M. $(x = 17 - y) \vee (y \leq 0)$

N. "undefined"

P. $x = 7 \wedge y = 0$

S. $(y = 0 \wedge x = 5 + y')$

T. $(x = 7 - y) \wedge (y \geq 0)$

_____ a. What is $\text{wp}(R, x=17)$ in **closed form**?

_____ b. What is the *weakest Q-adequate* loop Invariant for R with respect to post-condition ($x=17$) that guarantees termination?

_____ c. What is $\text{wlp}(R, x=17)$ in *closed form*?

_____ d. What is the *weakest Q-adequate* loop Invariant for R with respect to post-condition ($x=17$) that does **NOT** guarantee termination?

_____ e. What is $\text{sp}(R, x=5 \wedge y=2)$?

_____ f. What is $\text{sp}(R, x=5 \wedge y=-2)$?

_____ g. What is $\text{sp}(R, x=5)$?

2. (6 pts.) Consider the assertion of **weak** correctness: $\{t=5 \wedge z < 0\} S \{y=z+1 \wedge t=z\}$, where t, z, y are integers. Which of the following observations/facts **would** allow one to deduce that the assertion is false, and which **would not**? Circle either "would" or "would not" as appropriate, considering the observations individually. To compensate for random guessing, your score in points will be 2 times the number of [correct minus incorrect] answers, or 0 – whichever is greater. Therefore, if you are not more than 50% sure of your answer, consider skipping the problem.

- | | | |
|--|-------|-----------|
| a. $wp(S, y=z+1) = \{z > -5\}$ | would | would not |
| b. $(wp(S, true) = \{z > -5\}) \wedge (wlp(S, y=z) = \{t=5\})$ | would | would not |
| c. $wp(S, y \neq z) = \{z > -5\}$ | would | would not |

3. (6 pts.) Consider the assertion of **strong** correctness: $\{t=5 \wedge z < 0\} S \{y=z+1 \wedge t=z\}$ strongly, where t, z, y are integers. Which of the following observations/facts **would** allow one to deduce that the assertion is false, and which **would not**? Circle either "would" or "would not" as appropriate, considering the observations individually. To compensate for random guessing, your score in points will be 2 times the number of [correct minus incorrect] answers, or 0 – whichever is greater. Therefore, if you are not more than 50% sure of your answer, consider skipping the problem.

- | | | |
|---|-------|-----------|
| a. $wp(S, y=z+1) = \{z > -5\}$ | would | would not |
| b. $wp(S, y \neq z) = \{z > -5\}$ | would | would not |
| c. $sp(S, t=5 \wedge z \leq -5) \Rightarrow (y=z+1 \wedge t=z)$ | would | would not |

4. (6 pts.) Circle either "valid" or "invalid" for each of the following *hypothesized* Rules of Inference. To compensate for random guessing, your score in points will be 2 times the number of [correct minus incorrect] answers, or 0 – whichever is greater. Therefore, if you are not more than 50% sure of your answer, consider skipping the problem.

- | | | | |
|----|---|-------|---------|
| a. | $\frac{sp(S, P) \Rightarrow Q}{\{P\} S \{Q\} \text{ strongly}} \quad ?$ | valid | invalid |
| b. | $\frac{Q \Leftrightarrow sp(S, P)}{\{true\} S \{Q\}} \quad ?$ | valid | invalid |
| c. | $\frac{(wlp(S, Q) \wedge K) \Leftrightarrow P}{\{P\} S \{Q\}} \quad ?$ | valid | invalid |

5. (8 pts.) Complete the wlp rule for the if-then program statement:

$\text{wlp}(\text{if } b \text{ then } S, Q) \equiv \underline{\hspace{10cm}}$

Use the rule to determine:

$\text{wlp}(\text{if } A > B \text{ then } Z := A, Z = \text{Max}(A, B))$

Show ALL steps explicitly. Your solution must clearly demonstrate the correct use of the rule.